Scoping Comment B3 – Center for Biological Diversity

CENTER *for* BIOLOGICAL DIVERSITY *Because life is good.*

working through science, law and creative media to secure a future for all species, great or small, hovering on the brink of extinction.

VIA ELECTRONIC MAIL

September 1, 2016

Jennifer Whyte, BLM Project Manager
BLM Palm Springs South Coast Field Office
1201 Bird Center Drive
Palm Springs, CA 92262
Email: jwhyte@blm.gov

Re: Comments on the Proposed Supplemental Environmental Impact Statement & Supplemental Environmental Impact Report for the Palen Solar PV Project

Dear Project Manager Whyte,

These comments are provided by the Center for Biological Diversity ("Center") regarding the BLM's preparation of a Proposed Supplemental Environmental Impact Statement & Supplemental Environmental Impact Report for the Palen Solar PV Project (Supp. DEIS/EIR). I attended the August 4, 2016 public meeting in Palm Springs on behalf of the Center and provided comments at that time, although the BLM stated it was not actually recording the comments and would not consider them to be scoping comments that must be considered by the agency in preparing its Supp. DEIS/EIR. The Center is concerned with the lack of clarity on the part of BLM and the County in soliciting public input into this process and regarding how earlier environmental review documents and information, much of which is outdated, will be utilized in preparing the needed environmental review for the newly proposed project.

The Center is a non-profit environmental organization with more than 1 million members and online activists, including members who live in or visit Riverside County and the public lands where the proposed project would be sited. The Center uses science, policy and law to advocate for the conservation and recovery of species on the brink of extinction and the habitats they need to survive including the threatened desert tortoise, desert kit fox, Yuma clapper rail, and other species which may be affected by the proposed project. The Center strongly supports the development of renewable energy as a critical component of efforts to reduce greenhouse gas emissions, avoid the worst consequences of global warming, and to assist California in meeting emission reductions. The generation of electricity from solar power, in particular, is critical to shifting our energy system away from fossil fuels. However, like any project, proposed solar power projects must be thoughtfully planned to minimize impacts to the environment. To that end, renewable energy projects should be sited to avoid impacts to sensitive species and habitats, and be sited in proximity to the areas of electricity end-use in order to reduce the need for

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extensive new transmission corridors and the efficiency loss associated with extended energy transmission. Only by maintaining the highest environmental standards with regard to local impacts, and effects on species and habitat, can renewable energy production be truly sustainable.

While the California Energy Commission previously approved a solar trough project on this site, that approval has expired. Further, the BLM never approved the earlier proposals for a Right of Way (ROW) for a large-scale solar project on these public lands. Therefore, the Supp. DEIS/EIR cannot assume that the project will be approved and must take a fresh look at the proposal including alternatives.

Comments:

In addition to the issues that are identified in Attachment A to the Notice of Public Meeting, the following issues must be addressed.

NEPA Specific Issues:

- The BLM must consider the new January 14, 2011 guidance on NEPA reviews concerning avoidance, minimization and compensatory mitigation from the CEQ. Available at http://ceq.hss.doe.gov/current_developments/docs/Mitigation_and_Monitoring_Guidance_14Jan2011.pdf
- The BLM must also consider new guidance on NEPA review regarding GHGs. https://www.whitehouse.gov/sites/whitehouse.gov/files/documents/nepa_final_ghg_guidance.pdf Among the GHG related issues that must be considered in detail in the Supp. EIS/EIR calculating lost carbon sequestration when desert soils are disturbed and full life-cycle calculations of GHG production for the proposed project (including shipping).
- The BLM must also consider the changes in the land use designations and management actions under the DRECP once the Record of Decision is issued. Even if the original Palen project application was listed as a project that would not be *required* to comply with the new DRECP requirements, that does not mean that this amended proposal at the site should be exempted. But even if BLM believes that this proposal is subject to "grandfathering", the new data and information that forms the basis of the DRECP analysis must be considered when undertaking current environmental review of the newly proposed project at this site including all new data and information regarding biological resources, movement corridors, habitat connectivity, water resources, cultural resources, soils and others.

CEQA Specific Issues:

- Tiering under CEQA only allows reliance on the environmental review on which the final 2010 California Energy Commission Decision was based—not on any of the later review that was not certified or adopted by the Commission in a final decision. As such,

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because only the 2010 Decision was ever adopted, only the material that formed a basis for that decision can be considered in lieu of a certified EIR and tiered from for new environmental review.

- Because of the unique process and procedures before the California Energy Commission, which has a certified regulatory program and does not produce an EIR, there is not any one specific document that can be looked in that earlier environmental review for the 2010 decision, certainly not just the staff assessment. Rather, the County must look at the whole of the record before the Commission when it made its decision in 2010. The County must look at all documents, appendices, and testimony submitted to the Commission, as well as transcripts of the hearings, and the PMPD. The briefing before the Commission which consolidates much of the information should also be reviewed. The full docket for the original proceeding is available on the Commission website with links to all filed documents, unfortunately much of the key information is in appendices and hard to find in this large and unorganized record.[1]

- Among the important information that was part of the environmental review relied on in the 2010 Decision is the Geomorphic assessment of Palen Solar project site, APPENDIX A (SOIL & WATER REPORT) Date: February 18, 2010 (Andrew Collison) (attached hereto). This document is key for understanding later discussion regarding sand areas and where Mojave fringe-toed lizard habitat is found.

- The later environmental review undertaken by the Commission may provide helpful information[2] (although as noted above, because the decision was never finalized, that environmental review cannot be tiered from for a new or Supplemental EIR). The important information provided after the 2010 decision, in later CEC proceedings, that should be considered *includes, but is not limited to*, the following:

    - All exhibits and information (Exhibits 3000-3150), submitted by the Center regarding impacts of this project. A complete list of testimony and exhibits is attached (TN# 202780) and briefing can be found at: (TN # 202935 (opening brief, reopened hearings), 203017 (reply brief, reopened hearings)).
    - Information regarding impacts to MFTL at the Colorado Substation and Devers PV II line during construction (TN# 200065 (Helix report)).
    - Expert testimony from Al Muth regarding sand habitats and MFTL (TN# 200904 (opening), 200964 (rebuttal), testimony at hearing on October 29, 2013 (transcript at 201110), and photo discussed at hearing, 201075).
    - Expert testimony from Gordon Pratt regarding rare and unique invertebrates found in the project area: TN# 202492 (opening), 202762 (rebuttal) and testimony at hearing on July 30, 2014 (transcript at 202871).

[1] https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=09-AFC-07
[2] The documents submitted in the later amendment process are available at https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=09-AFC-07C

- Expert testimony from Bill Powers: TN# 202544 (opening), 202768 (rebuttal), testimony at hearing on July 30, 2014 (202871).
- Expert testimony from Pat Flanagan regarding local bird population and landscape level analysis: TN# 200892 (opening), 202558 (article), testimony at hearing on October 29, 2013 (transcript at 201110).
- Expert testimony from Shawn Smallwood concerning avian use of area, potential mortality, etc.: TN# 202698 (corrected opening testimony), 202764 (rebuttal), and testimony at hearing on July 30, 2014 (transcript at 202871).
- Expert testimony from Ileene Anderson concerning biological resources and air quality: TN# 200853 (opening), 201284 (air quality), 202558 (reopened hearings), and testimony at hearings on October 29, 2013, and July 30, 2014 (transcript at 202871).
- Expert testimony and information submitted by Basin and Range Watch in these proceedings including testimony at hearings.

New Information and Issues Not Adequately Considered in Earlier Review Documents:

- ***Avian impacts:*** New information regarding collision and impacts to migratory birds from photovoltaic solar panels is at solar project sites in the California deserts. Birds may be attracted to solar arrays because of their water-like reflective appearance, particularly within the California desert and at nearby facilities. Unfortunately, to date, baseline information has been inadequate. Moreover, the monitoring data and information regarding the impacts to avian species from PV projects in the area has not been released to the public. Although there is an inter-agency working group investigating this issue, there has to date been limited data. Recently, U.S Fish and Wildlife Service presented an overview of avian impacts from monitoring data on California desert solar projects[3], which needs to be included as part of the data set upon which the Supp. DEIS/R relies for impact analysis. A precautionary approach should be taken before approving any additional large-scale solar projects in this area. The threat of collision with solar panels needs to be addressed and steps taken to avoid these impacts.

- ***Desert Kit Fox impacts:*** The first documentation of canine distemper ever documented in desert kit foxes was diagnosed in late 2011 at the Genesis Solar Energy site quite near the proposed project site. The prior environmental review did not fully address canine distemper. Indeed the California Department of Fish and Wildlife submitted extensive comments on the Palen Project in 2013 regarding the potential impacts of passive relocation from solar sites on desert kit foxes and the lack of exploration of alternative techniques to determine the best practices[4] and these need to be updated and considered here. The need for avoidance and protective measures must be fully addressed along with appropriate mitigation and monitoring measures for canine distemper in desert kit foxes.

[3] http://blmsolar.anl.gov/program/avian-solar/docs/Avian-Solar_CWG_May_2016_Workshop_Slides.pdf at pg. 37-56
[4] http://docketpublic.energy.ca.gov/PublicDocuments/09-AFC-07C/TN200995_20131022T141658_Exhibit_2005__CDFW_Outline_for_Proposed_Desert_Kit_Fox_Health_M.pdf

- ***Mojave Fringe-toed Lizard impacts:*** While earlier reviews did contain significant information regarding MFTL and its habitat, the analysis of impacts of a large-scale project and the fencing was not adequate. More analysis needs to be done that addresses the value of all habitat types not only the most active sand areas.

- ***Invertebrates:*** Earlier reviews did not consider invertebrates that are unique to dunes ecosystems.

- ***Surface Hydrology Impacts:*** Earlier reviews were inadequate in identifying the hydrology of the region and likely impacts across the region from water extractions in this area.

- ***Impacts to Soils and other resources from loss of Cryptobiotic Crusts and Desert Pavement:*** Earlier reviews were inadequate in identifying loss of intact desert soils including cryptobiotic crusts and desert pavement and analyzing the impacts to a wide array of resources from those losses including air quality and wildlife. While some discussion of these issues was included in earlier reviews it was not robust and did not address the ecosystem wide impacts that can occur and even cascade with loss of soil crusts and desert pavement.

- ***Cultural Resource Impacts***: Cultural resources including sites and landscapes were not adequately identified or evaluated in earlier reviews. The area of the proposed project is rich in cultural sites and should be preserved, not destroyed. The Supp. EIS/EIR must take into account the new information learned during construction of nearby solar sites, particularly at the Genesis site, and if the project goes forward in any configuration at this site, new procedures must be put in place to ensure that any cultural resources that are impacted are properly handled.

- Earlier reviews did not consider the cultural significance of the unique invertebrates in this area to affected native American tribes. Public comment on this issue from the 2014 Hearings at Blythe should be fully reviewed.

- New information regarding the cumulative impacts to groundwater from the existing projects and the FERC permitted (but not yet built) Eagle Crest pump storage project must be fully evaluated as well as issue regarding how water use in this area impacts water in the Colorado River. While this issue has been raised in the past, it has never been resolved.

- The earlier reviews were inadequate in identifying sensitive habitats that must be avoided including, but not limited to: Mojave fringe-toed lizard habitat, active and semi-stabilized sand, desert wash, desert dry wash woodlands, connectivity and movement corridors for desert tortoise and other wildlife, avian use of the site and including avian migration corridors.

- All impacts must be fully avoided where feasible, pursuant to CEQA. Any remaining impacts must be minimized and fully mitigated.

- An alternative configuration that avoids all active dunes, shallow dunes, and semi-stabilized sand areas (Zones I, II, and III from preliminary geologic map, Collison figure 9) on the site must be fully evaluated.

- An alternative configuration that avoids all sand areas and MFTL habitat (as described above) and also avoids all large wash complexes including both the Central wash complex and Western wash complex (figure 7, Collison) must be fully evaluated.

- ***Movement Corridors:*** The proposed project layout creates a barrier to movement north and south across the landscape and heavily fragments the habitat. For example, the current proposed layout results in a narrow area south of the project between the I-10 and the project boundary, which is proposed to be fully fenced, and which creates a trap for wildlife. Recent experiences with heavy predation of both tortoises and roadrunners along very large area boundary fences at other large-solar projects must be taken into account and alternatives evaluated that could reduce such impacts. An alternative configuration that provides for a significant movement corridor across the site for desert tortoise and other terrestrial species (minimum of half (.5) mile wide) must be evaluated and should include both the Western and Central wash complexes.

- An alternative utilizing roof-top distributed solar should be fully evaluated. The Supp. DEIS/EIR should consider the gains made in efficiency and penetration of rooftop solar and parking lot based solar into the grid. The Supp. DEIS/EIR should review the full potential of that renewable energy resource as an alternative including but not limited to information in:

    - the recent NREL paper: "Rooftop Solar Photovoltaic Technical Potential in the United States: A Detailed Assessment, Pieter Gagnon, Robert Margolis, Jennifer Melius, Caleb Phillips, and Ryan Elmore, National Renewable Energy Laboratory, Technical Report NREL/TP-6A20-65298, January 2016 (available at http://www.nrel.gov/docs/fy16osti/65298.pdf and attached)

    - Umberger, Allyson, Distributed Generation: How Localized Energy Production Reduces Vulnerability to Outages and Environmental Damage in the Wake of Climate Change, 11-20-2012, Golden Gate Environmental Law Journal, volume 6, article 10 (available at http://digitalcommons.law.ggu.edu/gguelj/vol6/iss1/10)

- An alternative utilizing previously disturbed sites on public lands for solar PV including potentially on mine rehabilitation sites and other sites identified by EPA in its Re-Powering America report must be fully analyzed. (EPA reports and detailed mapping tools and other information available at https://www.epa.gov/re-powering)

- An alternative utilizing energy efficiency instead of new generation should be fully evaluated.

We look forward to reviewing a comprehensive and robust Supplemental EIS/EIR for the proposed project that fully addresses all potentially significant direct, indirect, and cumulative environmental effects. We urge the BLM and the County to ensure that when incorporating earlier environmental review, the Supplemental EIS/EIR provides updated identification and analysis to the present and ensures that the document provides a single cohesive environmental review for decision-makers and the public to review.

Sincerely,

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Attachments:

Attachment 1: Collison, Appendix A Soil and Water.

Attachment 2: List of Center exhibits from CEC process (with TN#s and links for retrieval from CEC site).

Attachment 3: CWG Workshop slides: # 37-56 only.

Attachment 4: CDFW proposed kit fox measures

Attachment 5: NREL 2016 Report

Attachment 1

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APPENDIX A (SOIL & WATER REPORT)

Date:	February 18, 2010
To:	Susan Sanders
CC:	Susan Lee, Alan Solomon, CEC workgroup for Palen
From:	Andrew Collison
PWA Project #:	CEC Palen
Subject:	**Geomorphic assessment of Palen Solar project site**

Objectives of this Appendix:

1. Provide a brief description of the project area's sand dunes and a discussion of the sand transport processes that created and now maintain the existing dunes.
2. Discussion of potential direct and indirect impacts of the proposed project and its two alternatives (attached) on the existing sand dune system and the processes that support them.
3. Mitigation for those impacts, or a well-supported conclusion that those impacts cannot be mitigated.

Summary of Key Findings

The proposed project footprint covers several different land units including (from southwest to northeast) a stable coarse gravel alluvial fan surface, a more active wind-blown sand area with relatively shallow sand deposits, and an area of deeper and more active vegetated sand dunes that appears to be Fringe Toed Lizard habitat. The northeastern portion of the project site lies within the Palen Dry Lake – Chuckwalla sand transport corridor, a regionally-significant geomorphic feature that provides sand necessary to supporting sand dune habitat including Fringe Toed Lizard habitat both on and off site. The sand corridor stretches down the Chuckwalla Valley to Blythe and the Colorado River. The project site is crossed by a series of small distributary alluvial fan channels, and two large wash complexes formed by concentrated drainage under I10.

For the Proposed Project Alternative most of the western solar array lies in a relatively stable area of alluvial fan with only 50 acres in the shallow sand dune zone (less active outer portion of the wind transport corridor). The off site geomorphic impacts from the western array will be relatively minor except for impacts to the large wash complex that crosses the south east corner of the western array. This wash supports a corridor of sand dunes and associated Fringe Toed Lizard (FTL) habitat around it, and it will be necessary to either avoid or mitigate for impacts to this area.

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The proposed eastern solar array is located in a much more geomorphically-active area, and has large direct and indirect impacts on sand dunes that support FTL. It directly impacts 890 acres of shallow vegetated sand dune in the outer zone of the PDL - Chuckwalla sand transport corridor (Zone 3 per Kenney, 2010), and 560 acres of deeper vegetated sand dunes that lie in the more active middle zone of the PDL – Chuckwalla sand transport corridor (Zone 2). The Proposed Alternative cuts the combined PDL-Chuckwalla and Palen wind-borne sand transport corridor in half by area (probably less than half by sand transport rate owing to more active conditions on the eastern edge of the corridor). I am not convinced of the validity of the applicant's report that less than 20% of the sand corridor transport volume will be affected by the project as proposed (Kenney, 2010, page 22) and suggest that the true value may be closer to 30-40%. Blocking such a large area and volume of the corridor will likely have a large impact both on-site and off-site, by disrupting sand transport to downwind sites that are biologically significant and that require new supplies of sand to replace sand lost to wind erosion. The area downwind of the project that will be substantially impacted under the applicant's Proposed Alternative is estimated to be 625 acres, with a further 787 acres moderately impacted, and minor but cumulative impacts felt regionally along the Chuckwalla wind transport corridor. It is unclear how or whether such large scale impacts to sand transport can be mitigated.

Two potential Project Alternatives have been assessed. Both offer advantages over the current project alternative by leaving a corridor for the major wash complexes and pulling some parts of the project site out of the vegetated dunes and wind transport corridor. The Applicant's Reconfigured Area Alternative directly impacts 613 acres of shallow sand dune (Zone 3 outer wind transport corridor) and 556 acres of more active deep sand dunes (Zone 2 mid wind transport corridor). It substantially impacts 686 acres of dune area (deep and shallow) off-site through indirect effects, and moderately impacts 507 acres of dune area off site.

The Reduced Area Alternative (Revised) has the smallest off-site impacts to wind transport of sand, as well as the smallest on-site impacts in the more sensitive areas of higher sand transport. It directly impacts 293 acres of shallow sand dunes (Zone 3 outer wind transport corridor) and approximately 3 acres of deeper dune (mid wind transport corridor). The off-site impacts are 210 acres of substantial impact and 160 acres of moderate impact, almost all of which is in the shallow dune area (outer wind transport corridor).

The Revised Reduced Area Alternative is superior from a geomorphic perspective to the other alternatives.

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Relationship Between Hydro-Geomorphic Processes and Biological Resources
This Appendix focuses on several hydro-geomorphic processes that play a significant role in the health of the ecosystem of the project site and its surroundings. These processes are wind transportation of sand relative to the creation, preservation and destruction of sand dunes, and water transport of sediment through the alluvial fan drainage system.

Wind Transport
The Fringe Toed Lizard relies on active sand dunes and a regular supply of fine wind blown sand for its habitat (Figure 1). Active sand dunes (dunes that have an active layer of mobile sand) exist in a state of dynamic equilibrium: they are continuously losing sand downwind due to erosion and transport, but that is offset by supplies of new sand from upwind (see Figure 2). If the upwind sand supply is cut off the dunes *deflate*; that is to say they lose sand downwind and shrink in size and depth (see Figure 3 for an example). The finest sand (which is most easily transported) is lost first with coarser sand and gravel being left behind to form an armor or lag. This combination of lag and thin sand deposits does not support FTL habitat.

Maintaining FTL habitat requires the regular addition of wind-blown sand from a reliable source. Most of the sand in the Chuckwalla Valley is transported via a series of sand transport corridors, controlled by wind direction and the availability of loose sand to be transported. The applicant's sand dune report (Kenney, 2010) provides a good explanation of the location of these corridors relative to the project site (see Figures 8 and 9). Two corridors come together just to the east of the proposed project: the Palen Valley corridor which runs from north to south along the eastern edge of the project and the Palen Dry Lake (PDL) – Chuckwalla Valley corridor which runs northwest to southeast through the northeastern half of the project.

The two corridors transport sand of different colors which makes them relatively easy to locate from aerial photos: grey sands along the PDL - Chuckwalla corridor and red sands along the Palen Valley corridor. The red Palen Valley corridor is prominent in aerial photos (see Figures 6 and 7). Sand delivered from upwind passes through dune areas including FTL habitat and is deposited, replenishing sand that has been lost downwind. In addition to the obvious biological impact of constructing a project in a dune area (direct loss of habitat), construction activities have two potential offsite impacts on sand transport corridors. Firstly, if the project footprint is constructed in a dune area it will cut off a supply of sand that would otherwise have been transported downwind to other dune areas. Dunes downwind of a constructed site will deflate over time as sand output is not matched by sand input. Secondly, new sand that would have been transported across the project footprint from upwind will potentially be cut off by drainage ditches, wind fences and above ground infrastructure. Thus, if a project is built into a wind corridor it will create a 'sand shadow' area where dune deflation occurs over time.

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Figure 1. Fringe Toed Lizard showing its preferred habitat of fine, loose sand. Source: Southwest Images.

Figure 2. Good FTL habitat showing 'plump', vegetated dunes connected by relatively deep, loose sand sheets.

Figure 3. Deflated former vegetated dune showing remnants of eroding dune under creosote bushes surrounded by an armored lag of coarse gravel and shallow, compacted sand. This habitat does not support FTL.

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Sand Transport by Alluvial Fan Washes

In addition to the two regional wind transport corridors identified by Dr. Kenney, sand can also be transported locally by washes. These carry sediment from upstream and distribute it on the alluvial fan where it is available to wind transport. Walking the large wash complexes it is clear that there is locally more sand available than there is on the equivalent elevation of the alluvial fan away from a channel. Figure 4 and 5 shows the contrast in conditions for two locations at the same elevation on the underlying fan. These wash processes create a zone of FTL habitat a few hundreds to a thousand feet wide along the three major wash complexes in the project area. Disrupting the drainage pattern (for example by channelizing the washes in hydraulically-efficient concrete channels deep below the fan surface) is likely to move sediment downstream at the expense of the surrounding habitat corridor. (The area where the channel discharges may however benefit from greater than before sand delivery.)

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Figure 4. Sparse sand on the mid alluvial fan area away from a major wash.

Figure 5. Much sandier conditions than Figure 4 in the Central Wash Complex indicating sand transport from the channel to the surrounding alluvial fan.

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Description of the Project Sites

I visited the Palen project site for a day on February 5th 2010, following a reconnaissance visit on January 12th 2010. Conditions on January 12th were warm and dry, with no recent rain. The February 5th visit was conducted the morning following a rainstorm. I drove the western boundary of the property along the BLM dirt road up to the northwest corner making stops at points of interest, and hiked a loop of approximately 6 miles along the northern project boundary to the northeast corner of the proposed impact area, returning westwards along a more southerly alignment. After this I drove the BLM road from the northwest corner southeast to the southern site boundary near I10. Finally I visited a large ephemeral wash that passed under I10 to assess the effects of concentrating several small washes into a single channel, as a reference condition for potential site drainage approaches. During the visit I logged my position on an aerial photo using a GPS linked to Google Earth, made field observations and took photos.

The site is located on an alluvial fan that drains from southwest to northeast towards Palen Dry Lake. The average slope across the site is 2 percent. There is a gradient of three major desert surfaces progressing from southwest to northeast that I detected on foot and confirmed by aerial photo. The boundaries between these areas are somewhat interwoven and gradual, but can be seen on aerial photos and in the field. There is a close agreement between the major units I mapped and the units as delineated by Dr. Kenney, as can be seen in our respective figures. In addition to mapping the major units I mapped a series of smaller land units related to fluvial drainage features.

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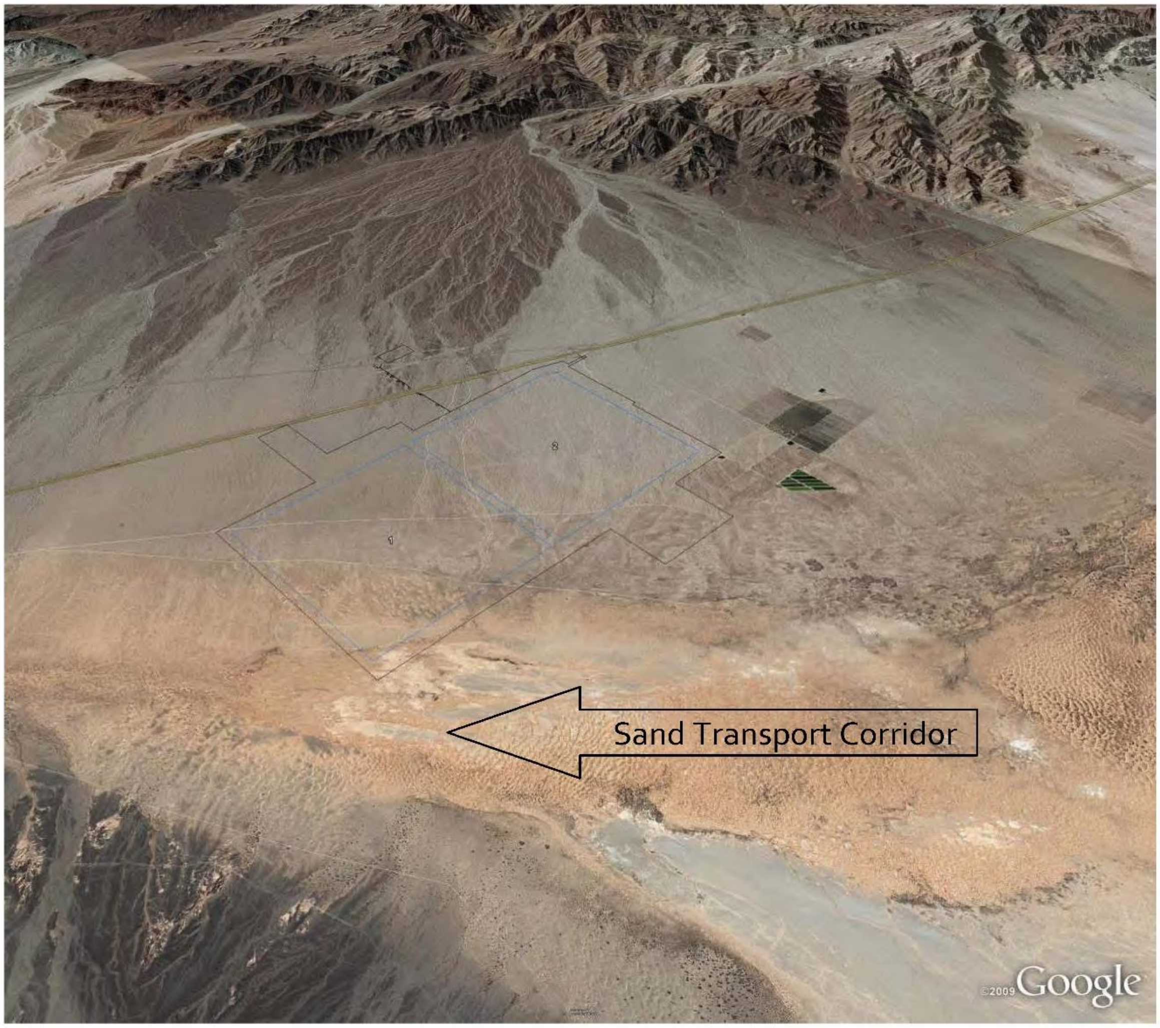

Figure 6. Setting of the Palen project site showing the major topographic units. Project boundary shown in gray, proposed solar arrays shown in blue, pale lines are the authors land unit boundaries. The intrusion of the eastern array into the sand transport corridor (red dunes and surrounding grey dunes) can clearly be seen.

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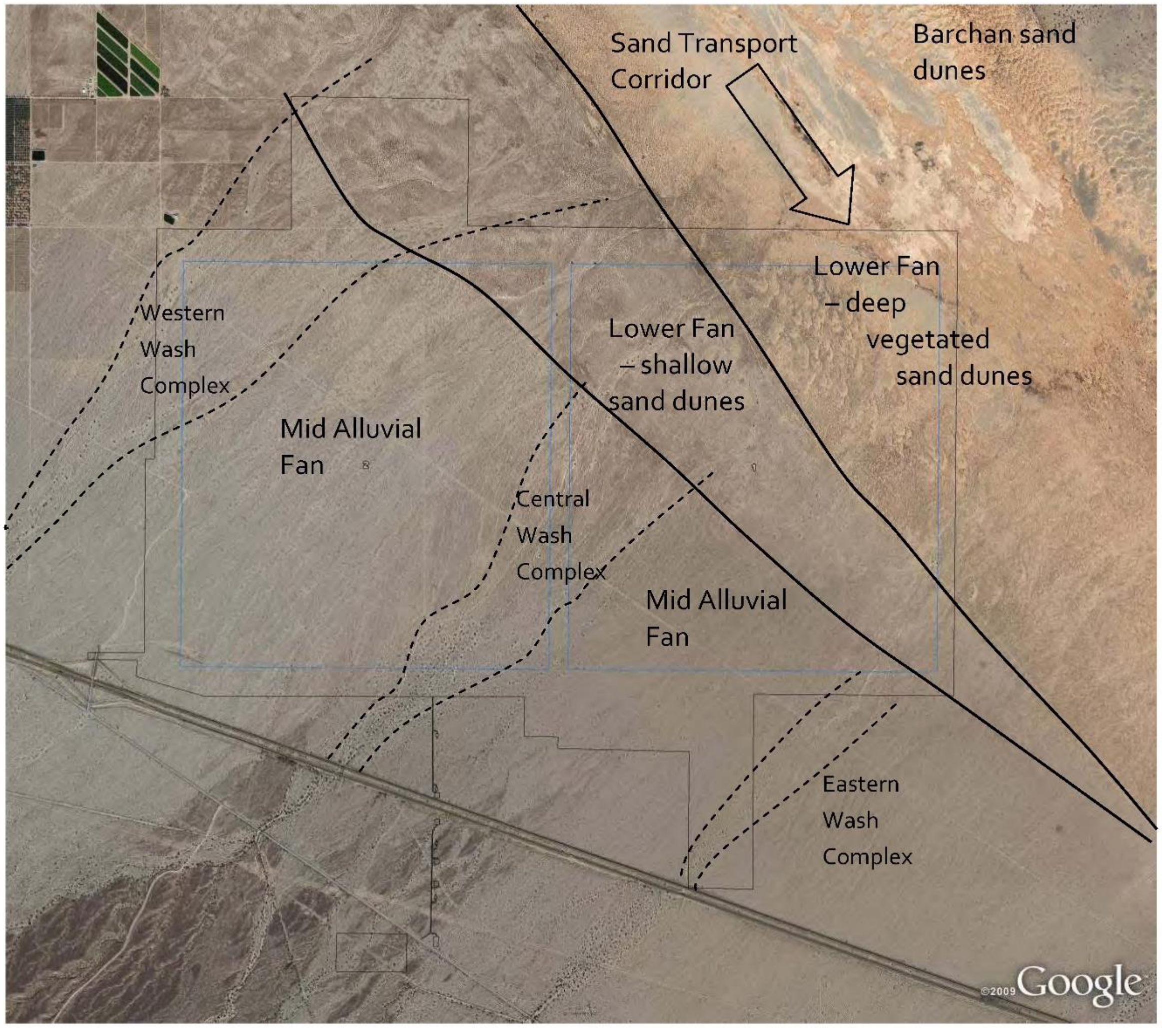

Figure 7. Distribution of major and minor land units on the Palen site. Project boundary shown in gray, proposed solar arrays shown in blue.

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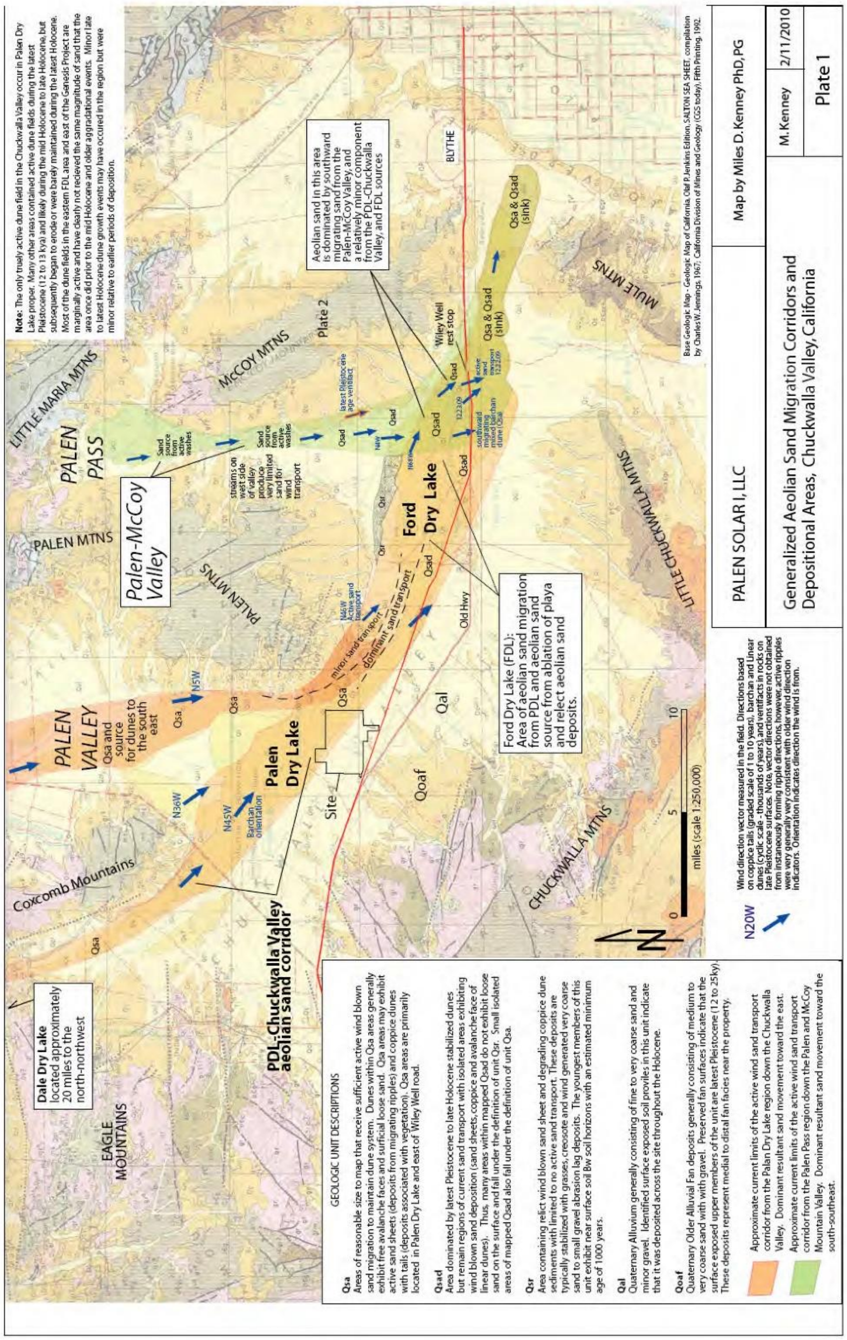

Figure 8. Generalized Sand Migration Corridors, Kenney 2010.

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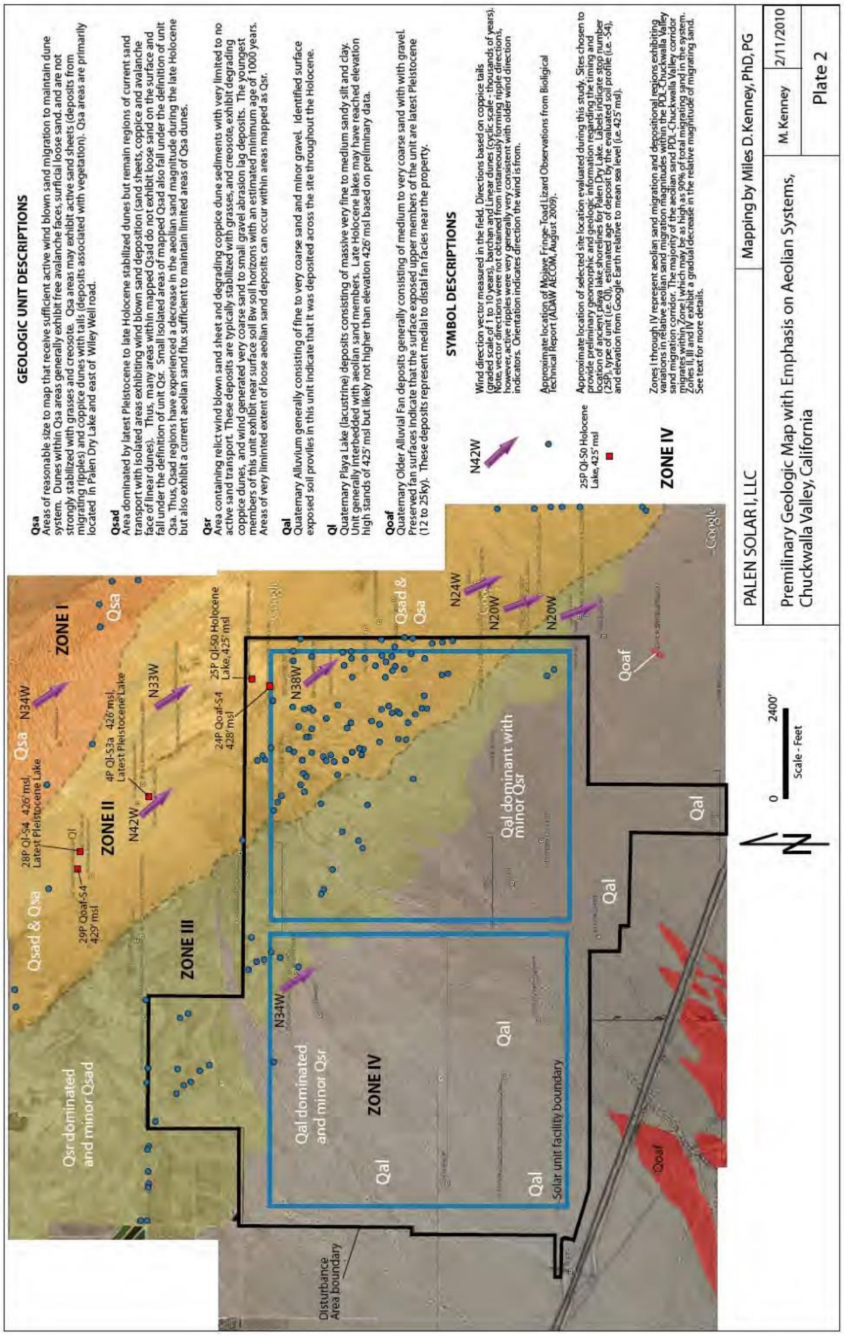

Figure 9. Detail of Generalized Sand Migration Corridors, Kenney 2010.

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Major Land Units

Mid Alluvial Fan Area – Degraded Vegetated Dunes with Lagged Alluvial Surfaces (corresponds to Zone 4 of Figure 9, Kenney, 2010)
(Note that the project is relatively low on the alluvial fan, and that the mid fan is the highest part of the alluvial fan occupied by the project site. The High Alluvial Fan area is found southwest of I10.)

In the southern and western sector of the project site the surface is a mixture of degraded vegetated dunes with thin coarse sand, and patches of alluvial gravel lag and desert varnish. This surface has been formed primarily by deposition of sand and gravel from alluvial fans (fluvial action) over hundreds of thousands of years, overlain with patches of vegetated sand dunes that formed from wind action during periods of greater sand availability. The sand dunes on the mid fan have subsequently degraded due to wind erosion and deflation (sand is being removed by the wind but not replaced). Deflation of the relict dunes is leaving behind the more resistant alluvial deposits as a protective lag of gravel. In many places the lag has formed desert varnish (a black coloration on the exposed surface of gravel particles). The presence of desert varnish suggests that parts of this surface have been stable and exposed in its current condition for many hundreds to thousands of years. There is little available sand for either transport to dunes down wind or to support Fringe Toe Lizard (FTL) habitat. What sand is present is coarse (1-2 mm) and there is abundant fine gravel (2 mm and larger). The vegetation cover is largely sparse creosote bushes and degraded dunes, with ironwood trees in the larger washes. This surface has a relatively stable condition and appears well suited for development compared with other parts of the site. Based on the applicant's site footprint (shown in Figures 6 and 7), the proposed western solar array lies almost completely on this surface (1,341 acres), with the exception of its northeast corner which intrudes into the Lower Fan Surface and sand transportation corridor by several hundred feet (52 acres). The 450 acres in the southwest of the eastern solar array lies on this surface, representing 32% of the area of the array.

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Figure 10. Typical degraded dune and coarse gravel lag on the mid fan surface. View is from the west looking across the proposed western solar array site to Palen Dry Lake.

Figure 11. Close up of dune and lag mixture

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Figure 12. Stable mid fan area with gravel lag

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Lower Alluvial Fan – Shallow Vegetated Sand Dunes and Sand Transport Corridor (Zone 3 of Figure 9)
Moving north and east the fan surface has sandier conditions and a transition from creosote bushes to grasses. This area has shallow vegetated sand dunes and sand sheets that are less degraded and that have more abundant sand than the dunes in the mid fan. The dunes appear to be in relative equilibrium – losses of sand due to wind erosion are matched by deposition of sand from upwind. The sand is finer than in the mid fan area, with some areas that appear suited to FTL habitat (confirmed by the presence of FTL as shown in the applicant's figure (Figure 9). There are abundant large rodent holes in the sand, unlike in the Mid Fan, implying that there is sufficient depth of sand for burrows. There is evidence of moderate levels of wind-borne sand transport, and this surface appears to form the outer zone of the sand transport corridor (as shown in the applicant's figure, Figure 8). Its southwest boundary appears to coincide with the southwest boundary of the Chuckwalla sand transportation corridor drawn by Dr. Miles Kenney in his assessment of sand transport and deposition in the Chuckwalla Valley (see Figures 8 and 9). (Note that while the western boundary of the sand transport corridor coincides with the boundary between the Mid and Lower Alluvial Fan, the wind transport corridor extends east into the Lower Fan – Deep Vegetated Sand Dunes and Dry Lake areas as well, and is not confined to the Lower Alluvial Fan.) The boundary was mapped in the field in two locations which appear on the aerial photo to trace a line of different vegetation and topography. This surface is less stable than the mid fan, appears to have a higher potential habitat value for FTL, and appears less well suited for development of infrastructure. Based on Figure 7 a 559 acres swath of the eastern solar array equivalent in area to approximately 40% of its surface area running from the northwest corner to the southeast corner lies within this zone.

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Figure 13. Vegetated dunes in the shallow vegetated sand dune and sand transport corridor area

Figure 14. Sandier conditions showing rodent burrows and fine surface sand. View is from center of proposed eastern solar array looking east towards Palen Lake.

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Lower Alluvial Fan – Deeper Vegetated Sand Dunes and Sand Transport Corridor (Zone 2 of Figure 9)
Moving north and east the vegetated dunes become deeper and the sand more abundant. This area has hummocky vegetated dunes with greater topographic expression than the zone to the west, implying that they are more actively supplied by sand. This area appears very well suited for FTL habitat, and coincides with observed FTL activity (see Figure 9). The eastern solar array has a footprint of 378 acres in this zone, equivalent to 27% of the array footprint. This zone of the sand transport corridor is more active than the Shallow Vegetated Sand Dunes, though less active than the area of unvegetated barchan dunes to the east (off the project area).

Figure 15. Conditions in the Lower Fan – deeper vegetated sand dune surface showing potential Fringe Toed Lizard habitat. View is from center of proposed eastern solar array looking north.

Figure 16. More abundant sand showing in the side of the dirt road.

Drainage Features

Overlain on the major landscape units there are a series of drainage lines that cross the site from southwest to northeast. I10 is an important local control on drainage across the project site since it intercepts a large number of ephemeral washes draining towards the site from upfan (southwest). These channels are captured by a series of berms and interceptor channels that run parallel with I10, periodically funneling the collected water under I10 at bridges and creating larger washes that pass onto the mid fan. Thus the site has two types of wash: minor washes whose headwaters have been captured by the I10 interceptor drains and that only drain a small area between I10 and the project boundary, and two major wash complexes that have captured all the small drainages upslope of I10 and that pass under the freeway and onto the project site. The I10 drainage collection and large washes also provide potential analogues for what concentrated drainage off or around the Palen project site may look and function like (discussed below).

Minor ephemeral washes

Approximately a hundred minor washes cross the site from southwest to northeast, draining the area downfan of I10 towards Palen Dry Lake (many channels do not reach the lake but fade out on the vegetated sand dune surface. These channels are typically very subtle, with a width of 2-10 feet and a depth of 3-9 inches. They are found approximately every 100 feet when traversing along a contour on the mid fan surface. There are sinuous and braided channels, with many channels showing evidence of recent flow on February 5th. Evidence of flow and small amounts of sediment transport included dampness, washed out dirt roads where they crossed channels, fresh veneers of sediment deposits, and small knickpoints and scour features of a few inches depth indicating local erosion. Based on the position of the damp ground flow was probably in the order of 1-2 inches deep through the small channels.

Figure 17. Minor ephemeral wash

Major ephemeral washes

There are 2 major ephemeral wash complexes that cross the site from southwest to northeast, draining the area downfan of I10 towards Palen Dry Lake. A third wash complex lies just to the southeast. Both major washes were traced from the western project boundary to Palen Dry Lake. The major washes are found as complexes of 10-20 braided channels, with each channel being approximately 10-50 feet wide. The wash complexes widen out from their constriction at I10 and are approximately 1,500 feet wide after a mile, after which they become very dispersed, lose definition and resemble minor washes. Within a mile of I10 the major washes have created sandy zones approximately 1,500 feet wide overlain on the less sandy alluvial gravel or thin sand sheets. These areas appear to be potential FTL habitat, with vegetated dunes.

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The washes appear to be a local, smaller version of the regional wind-borne sand transport corridors discussed earlier, supplying sand to a narrow surrounding zone. The northern wash travels further between its construction on I10 and the project site (1.4 miles) and is more dispersed than the central wash, which crossed into the proposed solar array blocks within 0.7 mile from I10. Thus the central wash carries more sand and has created a wider sand corridor around it in the project area than the northern wash.

Figure 18. One of the main channels in the northern major wash complex. Photo is from close to the western project boundary looking east across the project site towards Palen Dry Lake.

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Figure 19. The same major wash as Figure 15 in the middle of the proposed western solar array, showing the channel losing capacity as it flows towards Palen Dry Lake.

Figure 20. The central major wash complex in the center of the site has generated a corridor of sandy dune conditions around it, and supports trees.

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Potential Project Impacts

Impacts to the Mid Fan Area
Most of the mid fan is relatively stable, with little evidence of active sand transport outside of the major washes. From a geomorphic perspective construction of the project on the mid fan area should have little off-site impact, with the exclusion of the central major wash complex. Because there is little sediment transport occurring on this surface construction of the proposed project does not appear likely to disrupt the movement of sediment to habitat areas elsewhere. Noting the caveat that the author of this report is not a biologist, the mid fan does not appear to support FTL habitat, so direct habitat impacts do not appear to be as significant as elsewhere on the project site, though this should be confirmed by a biologist.

Potential Avoidance and Mitigation of Impacts to the Mid Fan Area
None proposed on geomorphic grounds.

Lower Alluvial Fan Area – Shallow Vegetated Sand Dunes
The Lower Fan – Shallow Vegetated Sand Dunes area will be directly impacted by the proposed eastern solar array block, and a small portion will be directly impacted by the proposed western solar array. Construction will completely grade and cover this area, and the construction of the site and wind fences will prevent sand from migrating through this area south to other dune areas located southeast of the project area. A biological assessment by a qualified professional is required to determine the significance of the habitat value of the area to be graded, but it appears likely to include removal of marginal FTL habitat. Since this area lies in the outer edge of the Chuckwalla sand transport corridor construction activities here will have some off-site impacts (discussed below).

Potential Avoidance and Mitigation of Impacts to the Lower Fan Area – Shallow Vegetated Sand Dunes
Mitigation of biological impacts is beyond the scope of this report. It is recommended that the eastern solar array and associated wind fences and infrastructure is reduced in size to achieve less than significant impacts in the shallow dune area and downwind.

Lower Alluvial Fan Area – Deeper Vegetated Sand Dunes
The Lower Fan – Deeper Vegetated Sand Dunes area will be directly impacted by the proposed eastern solar array block. Construction will completely grade and cover this area, and the construction of the site and wind fences will prevent sand from migrating through this area south to other dune areas located southeast of the project area. A biological assessment by a qualified professional is required to determine the significance of the habitat value of the area to be graded, but it appears likely to include removal of high quality FTL habitat. Since this area lies in the middle zone of the Chuckwalla sand transport corridor construction activities here will have substantial off site impacts (discussed below).

Potential Avoidance and Mitigation of Impacts to the Lower Fan Area – Deeper Vegetated Sand Dunes

Mitigation of biological impacts is beyond the scope of this report. It is recommended that the eastern solar array and associated wind fences and infrastructure is completely removed from this part of the sand transport corridor.

Off-Site Project Impacts to the PDL - Chuckwalla Wind Transport Corridor

The proposed eastern solar array lies directly in the PDL - Chuckwalla sand transport corridor as mapped by Dr. Kenney (see Figures 8-9). The overall project boundary appears to cover approximately 50% of the width of the corridor, though area does not correspond directly with sediment transport rates. Dr. Kenney divides the corridor into different zones of activity based on the amount of sand transported, stating that Zone 1 (off the project site) transports "a minimum of 80%" of the total volume of sand within the corridor, sand migration within Zone 2 is "moderately strong", and sand transport in Zone 3 is "relatively low" (all quotes from Kenney 2010, page 22). The implication of this statement is that less than 20% of the sand transport could be affected by the project footprint. I am in agreement regarding the relative assessments of activity within each zone (high, medium and low rates in Zones 1,2 and 3 respectively), but in the absence of quantitative data I am not convinced the "minimum of 80%" value for Zone 1 in the project area is correct. This number may be appropriate for the area of wind corridor a mile north of the project where there are active barchan dunes on the eastern side and where Zone 1 is much wider, but Zone 1 narrows close to the project (Figure 21) and aerial photos suggest that there is a more even balance in active sand transport between east and west sides of the corridor (Figure 22), and hence a greater percentage of sand transport on the project area that could be impacted by the project.

With a combination of grading, construction, infrastructure and wind fences the project will have a substantial on-site impact, and will likely have a substantial off-site impact on sand transport by wind. The Chuckwalla sand corridor is a major source of sand that supports sand dunes and FTL habitat down valley (for example the barchan sand dune field south of I10 near Wiley Well Rest Stop). Because most sand transport takes place close the ground (within 10 feet of the ground surface) fences and solar arrays are very effective at blocking sand transport.

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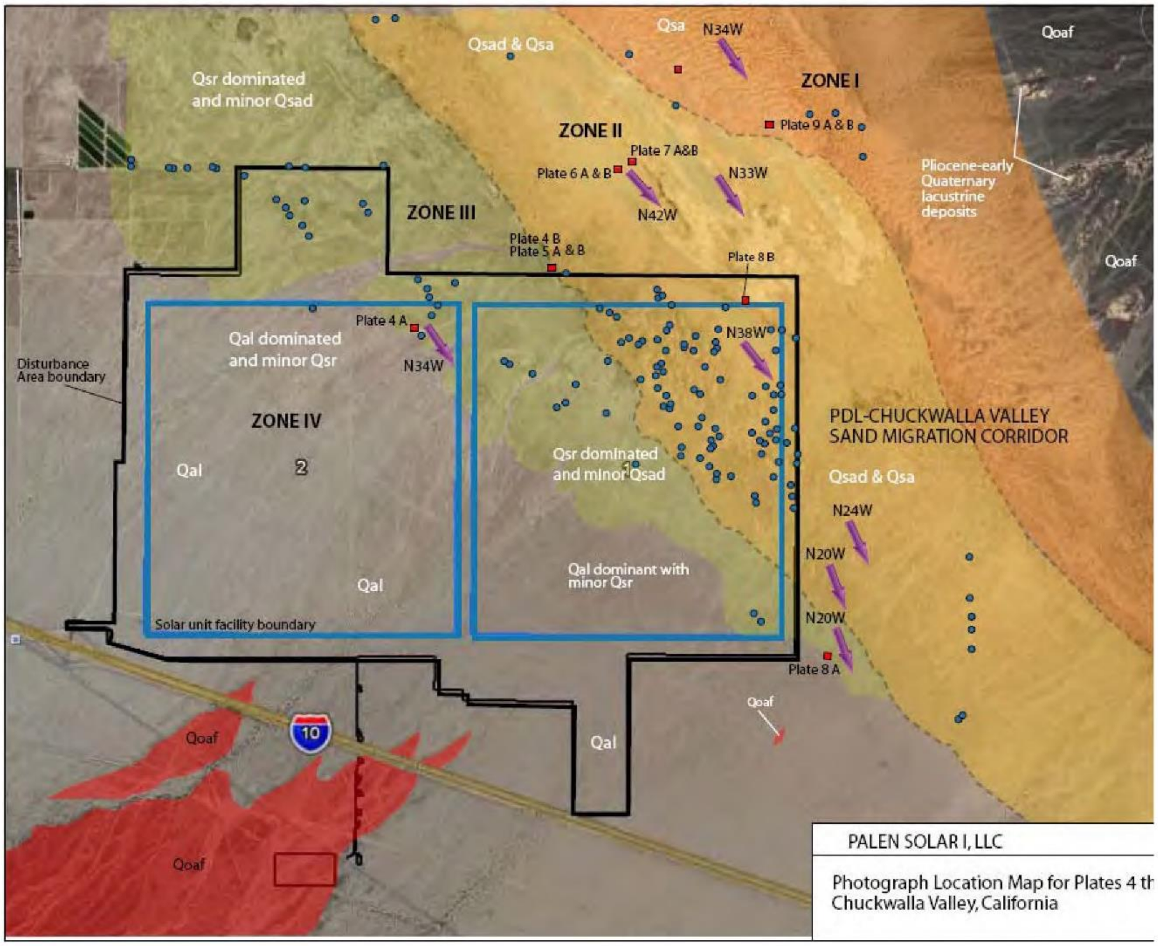

Figure 21. Detail of Dr. Kenney's sand transport map showing the constriction in Zone 1 adjacent to the project (Kenney, 2010).

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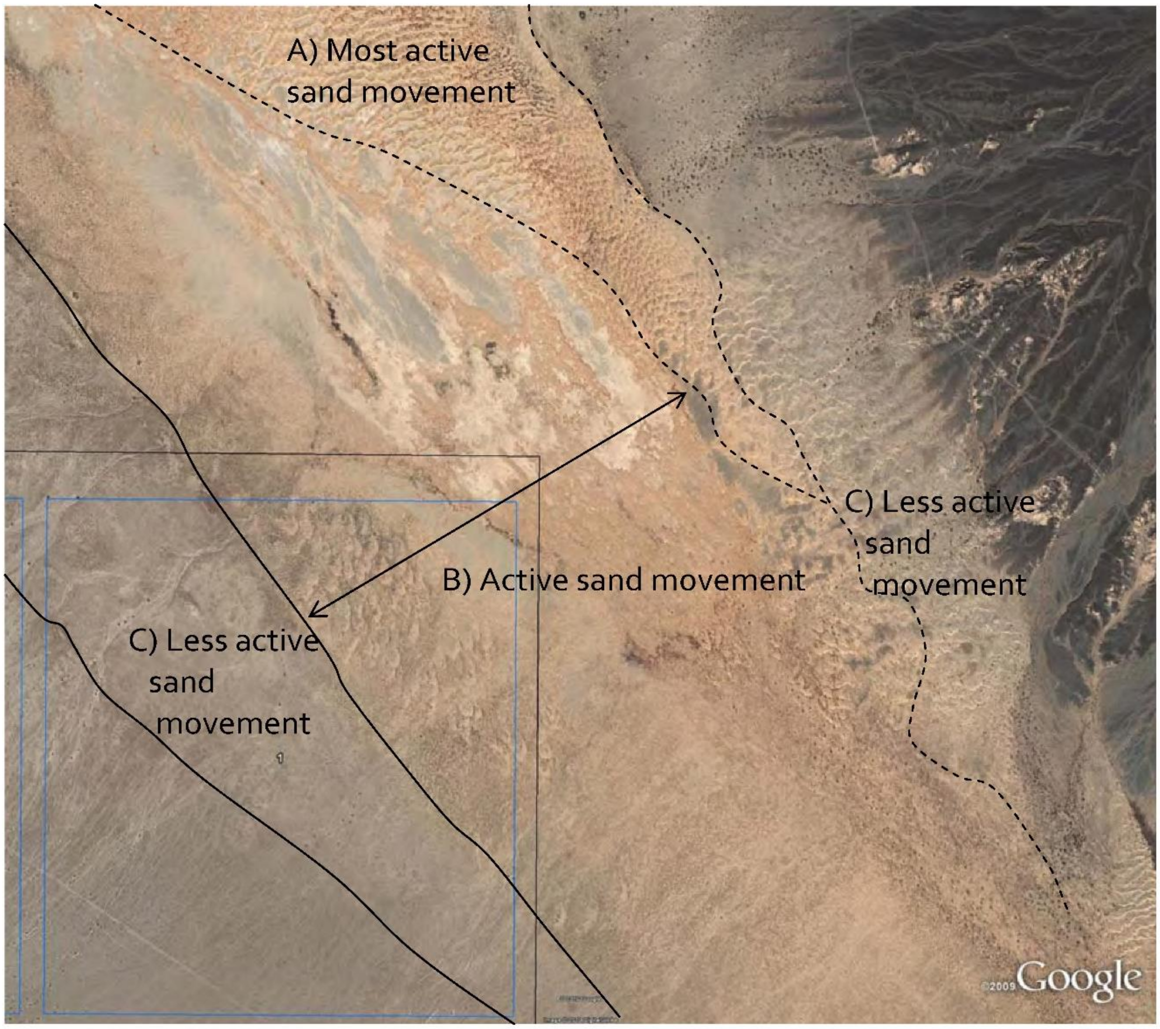

Figure 22. Aerial photo showing the sand transport corridor at the northeast corner of the project. Solid lines approximate Kenney's western boundaries for Zones 2 and 3. Dashed lines are the author's interpretation of sand transport activity. Assumed transport rates decrease from A-C. The photo suggests that the project may disrupt more than the <20% of the sand transport suggested by Kenney.

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In order to assess the likely extent of off-site impacts of constructing the project in the sand transport corridor I conducted a visual, qualitative assessment with the following assumptions:

1. The project as proposed significantly blocks the PDL – Chuckwalla corridor coming from the northwest before its confluence with the Palen Valley corridor, but largely leaves the Palen Valley corridor coming from the north unblocked
2. The Palen Valley sand transport corridor transports much more sand than the PDL – Chuckwalla corridor, as evidenced by the presence of barchan dunes and other features
3. Immediately downwind of the project where it intrudes into the sand transport corridor there will be a zone of impact in which wind erosion deflates the sand dunes over a period of decades, leaving them in a degraded condition
4. At some point downwind of the project mixing of sand from the Palen Valley sand corridor will offset reductions in sand from the PDL – Chuckwalla corridor upwind of the confluence, marking the end of the impact zone
5. The distance of downwind impact is related to the width of project intrusion into the sand corridor, the length of intrusion into the sand corridor, and the distance required for mixing of sand from both corridors to restore equilibrium conditions

Providing a quantitative definition of the zone of impact would require a sand budget for both corridors, detailed wind speed and direction data from the site, and data on sand mixing rates. In the absence of such data it is possible to make an estimate of the distance needed for mixing to occur since the two sand corridors are different colors. In aerial photos we can see that it takes several thousand feet for the red and gray sand to merge downwind of the confluence. Based on these observations and assumptions I mapped potential impact zones around the project site, and for the potential project alternatives.

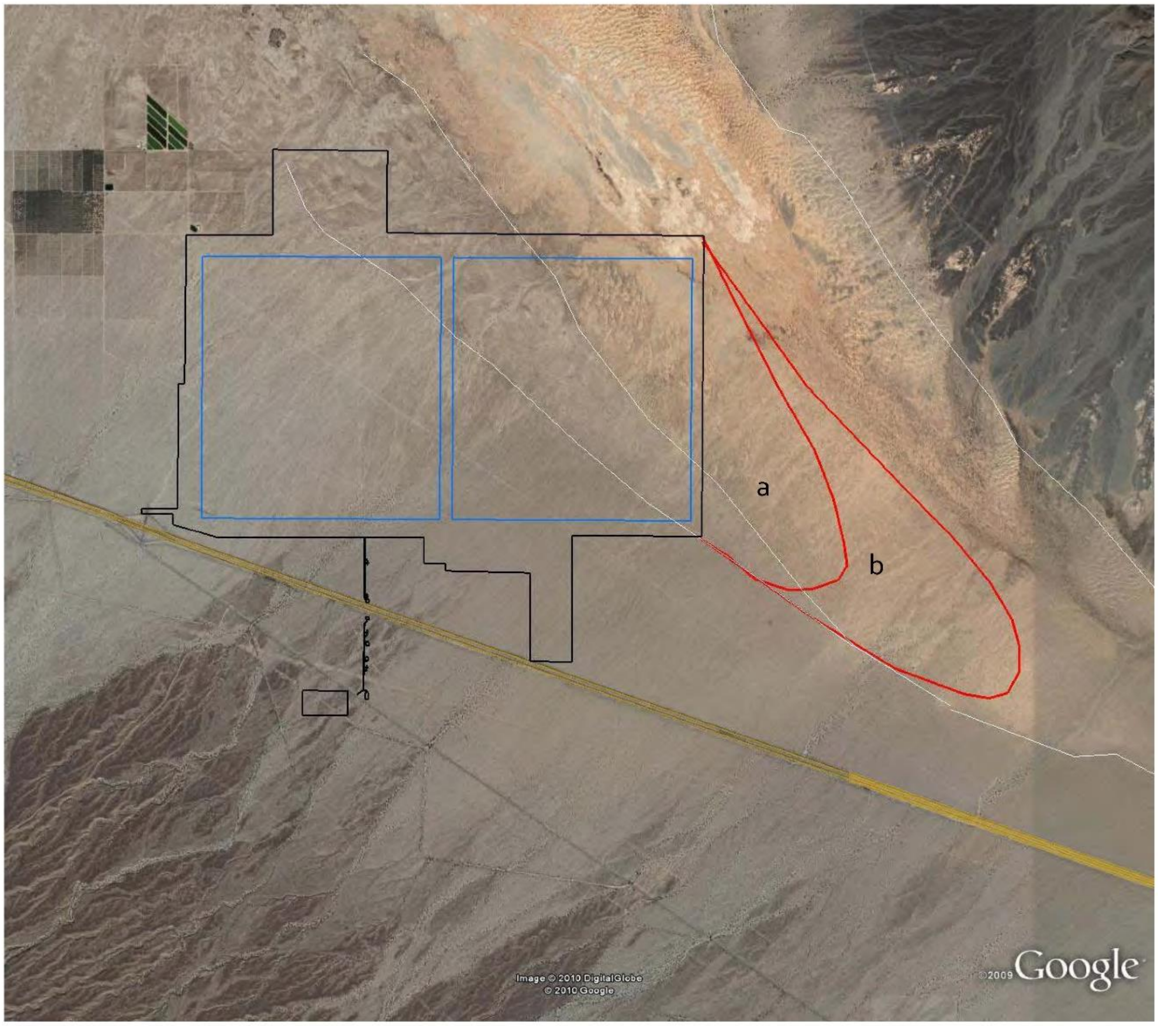

Figure 23. Estimated Potential Zone of Offsite Impacts Due to Wind Transport Disruption.

Figure 23 shows the area of substantial and moderate impacts. I assume that in zone a there would be little mixing of sand from the Palen Valley corridor, so that deflation of sand dunes would not be offset by the replacement of sand. In zone b I assume that limited mixing would occur, so that deflation of existing sand would be partially offset by the addition of sand from the Palen Valley corridor. Zone a (the zone of substantial off-site impacts) has an area of 625 acres. Zone b (the zone of moderate off-site impacts) has an area of 787 acres.

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Potential Avoidance and Mitigation of Impacts to the Chuckwalla Wind Transport Corridor

It is unclear how impacts can be mitigated in this area. It is recommended that the eastern solar array and associated wind fences and infrastructure is either removed, or that the footprint of the site is relocated west to pull the project out of the more active portions of the Chuckwalla sand transportation corridor (Zone 2). If the eastern solar array and associated infrastructure is removed/relocated, the intrusion of the western solar array into the wind corridor is unlikely by itself to be a significant impact since it constitutes a small percentage of the corridor width.

Impacts to the Northern Major Wash Complex

The northern major wash is relatively dispersed where it crosses the project boundary, and makes a relatively small contribution to sand transport. There is slightly more vegetation around the northern wash than the surrounding fan areas (for example trees along the main drainage lines) but there does not appear to be FTL habitat. Wind fencing, grading and channelization would eliminate the wash itself but likely not have significant indirect geomorphic impacts off site.

Potential Avoidance and Mitigation of Impacts to the Northern Major Wash Complex

1. The northern wash could be turned into one of the main drainage lines through the project site, preserving its existing wash habitat and functioning as a wildlife corridor through the site. While hydrologic and sediment transport calculations would be required, it appears as if a corridor of approximately 400 feet would preserve most of the existing channels and allow for dispersed flow. The corridor would require a low berm to prevent flooding of the site, and hydraulic calculations may show the need for protective armor to prevent erosion of infrastructure.
2. Based on observations of the drainage channels under I10 the northern drainage could realigned north of the project site rather than being placed in a concrete channel, and still provide equivalent quality habitat as existing conditions, as well as functioning as a wildlife corridor. Some local scour protection may be needed to achieve this.

Impacts to the Central Major Wash Complex

Dr. Kenney's report states "Local drainages within the Project site appear to be a very minor aeolian sand source but the drainages do not produce sand at a rate that would by itself support active sand dunes sufficient for MFTL habitat. Thus, a decrease of drainage flow within the Project site after construction will not adversely affect identified MFTL habitat outside the Project site after construction" (page 22, Kenney, 2010). The map of FTL sightings does not show lizards in the three major washes, but the contrast between Figures 4 and 5 demonstrates the significant increase in sand and vegetation associated with the Central Wash Complex. The wash visually and by substrate closely resembles the areas where FTL have been observed. The Central Major Wash does appear to form a small sand transport corridor

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through the proposed western solar array and appears to support trees and denser vegetation than elsewhere on the fan. Construction activities, the placement of a wind fence across the wash, and channelization of the wash in an artificial drainage channel are all likely to cause significant direct and indirect impacts to the corridor, and to dunes surrounding it. These proposed activities will disrupt sand transport by the wash that is subsequently redistributed by wind action along the corridor, providing habitat. I was not able to determine in the time available whether the wash complex provides a significant contribution of sand to the larger sand transport corridor (mapped as the Lower Fan units in Figure 7) but it appears likely that the vegetated dunes here are somewhat reliant on sand from this wash, and so this area could also be indirectly impacted by changes made to the wash, unless mitigated. Impacts to the central wash complex are considered to be substantial.

Potential Avoidance and Mitigation Impacts to the Central Major Wash

1. Avoid wash. This would require the southeastern corner of the western solar array to be removed or relocated to leave the wash in place. If any of the project is relocated the mid fan area west of the currently proposed project boundary appears to be most suited since this area resembles the western portion of the western solar array (stable alluvial fan).
2. Realign wash. Based on observations of the channels passing under I10 it should be feasible to realign the wash within low earth berms and pass it around or through the proposed site. This should be feasible without using concrete or hardened channels, though an erosion and sediment transport assessment will be needed to confirm this and to ensure that there is sufficient coarse material in the channel in the proposed relocation site. Relocation could occur to the south of the proposed solar arrays, directing flow to the south end of Palen Dry Lake.

Impacts Due to the Drainage Plan

It is believed that the drainage plan for Palen involves constructing an interceptor channel around the south and west project boundaries, collecting flows and passing them around the project for discharge onto the alluvial fan downslope. In order to assess whether such a plan is likely to cause impacts I visited I10 to look at a drainage that passes through the freeway (the Central Major Wash complex). The pattern of major and minor washes may be an analogue for conditions following construction of a solar array and drainage plan at Palen.

I10 as a Reference Site for the Palen Drainage Plan

Numerous small ephemeral channels heading towards I10 have been intercepted and concentrated into two drainage channels. The westerly channel intercepts a 1.6 mile width of upper alluvial fan, and the easterly channel intercepts 1.9 miles of fan. The flow is collected into a single engineered earth channel then passed under I10 in a concrete trapezoidal channel and discharged back onto the fan surface

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downslope. A similar approach is proposed by the applicant for Palen, with an interceptor channel that collects flow from the ephemeral washes, routes it around the solar arrays, and discharges flow back onto the fan below. I visited the easterly collector channel and walked it for a distance of 1,000 feet onto the mid fan surface. The collector channel that ran parallel with I10, though artificial, had a somewhat natural appearance and function (earth banks and bed, apparently stable, no excessive erosion or deposition, some typical wash vegetation present in the channel). The wash formed a slightly incised single channel immediately downstream of I10 where it passed from the concrete channel onto the mid fan (vertical banks approximately 4 feet high, with a width of 50 feet). However, incision ceased within a few hundred feet of I10 and the channel widened and formed braids. The channel showed evidence of higher energy flows in the presence of scour features and very coarse bed material (coarse gravel and cobble sized sediment). However, the gravel and cobble bed appeared to be a natural armor layer that formed from selective scour of the finer sand, forming a protective layer. Within a few hundred feet of I10 the wash supported typical large wash morphology and vegetation, and appeared to be depositing the sand eroded upstream along its margins, creating good quality sandy habitat.

Figure 24. Interceptor channel running parallel with I10 (flow towards viewer)

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Figure 25. Close up of vegetation in the constructed interceptor channel

Figure 26. Interceptor channel passes under I10 (flow away from viewer)

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Figure 27. Incised and scoured channel immediately downstream of I10. Bank detail shown in next photo.

Figure 28. Channel bank is 4 feet high. Gravel in the fan provides armor that stabilizes the channel.

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Figure 29. Channel widens and becomes less incised 300 feet downstream of I10

Figure 30. Channel widens and becomes less incised 800 feet downstream of I10

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Based on this reconnaissance-level assessment it seems likely that it would be feasible to capture the minor washes at the project boundary and pass them into a preserved major wash that would provide habitat value and natural function provided that:

- The watershed area of the captured channels is similar to that of the reference reaches assessed
- The fan gradient at the discharge point is similar or less
- The sediment at discharge point has some coarse gravel and cobble to form an armor (or this is imported for a few hundred feet)

The first two assumptions are likely to be correct, though the third assumption is likely not correct since sediment tends to be finer downfan and the proposed discharge locations may be more prone to scour than the area near I10. If this is the case cobble and gravel would need to be added to provide an armor layer.

If these conditions can be met it appears that it is feasible to bring water around the Palen site in relatively natural channels that may provide habitat and migration value. It also appears likely that water may be discharged back on to the fan surface with minimal impact, provided that there is a cobble supply to armor the first few hundred feet of discharge. There is potential to develop the drainage channels using more natural channel morphology than currently proposed, to provide biological functions and act as wildlife corridors.

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Discussion of Project Alternatives

Two potential project alternatives have been reviewed: the Palen Applicant Reconfigured Alternative and the Palen Reduced Acreage (Revised) Alternative

<u>Palen Applicant Reconfigured Alternative</u>

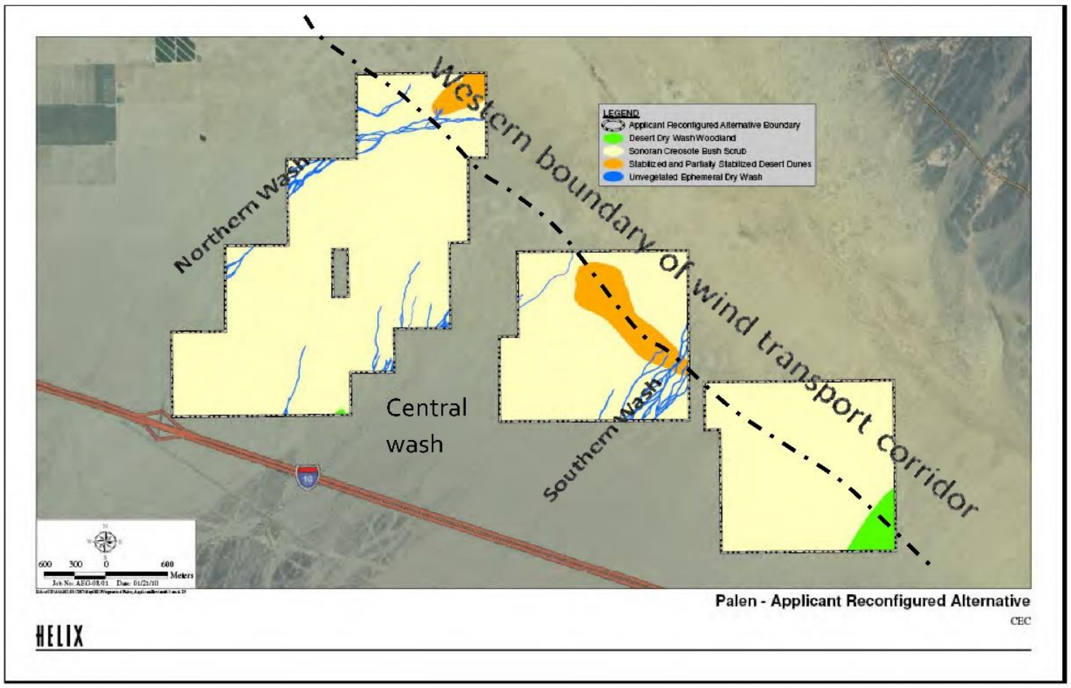

Figure 31. Palen Applicant Reconfigured Alternative. Source: Helix, 2010.

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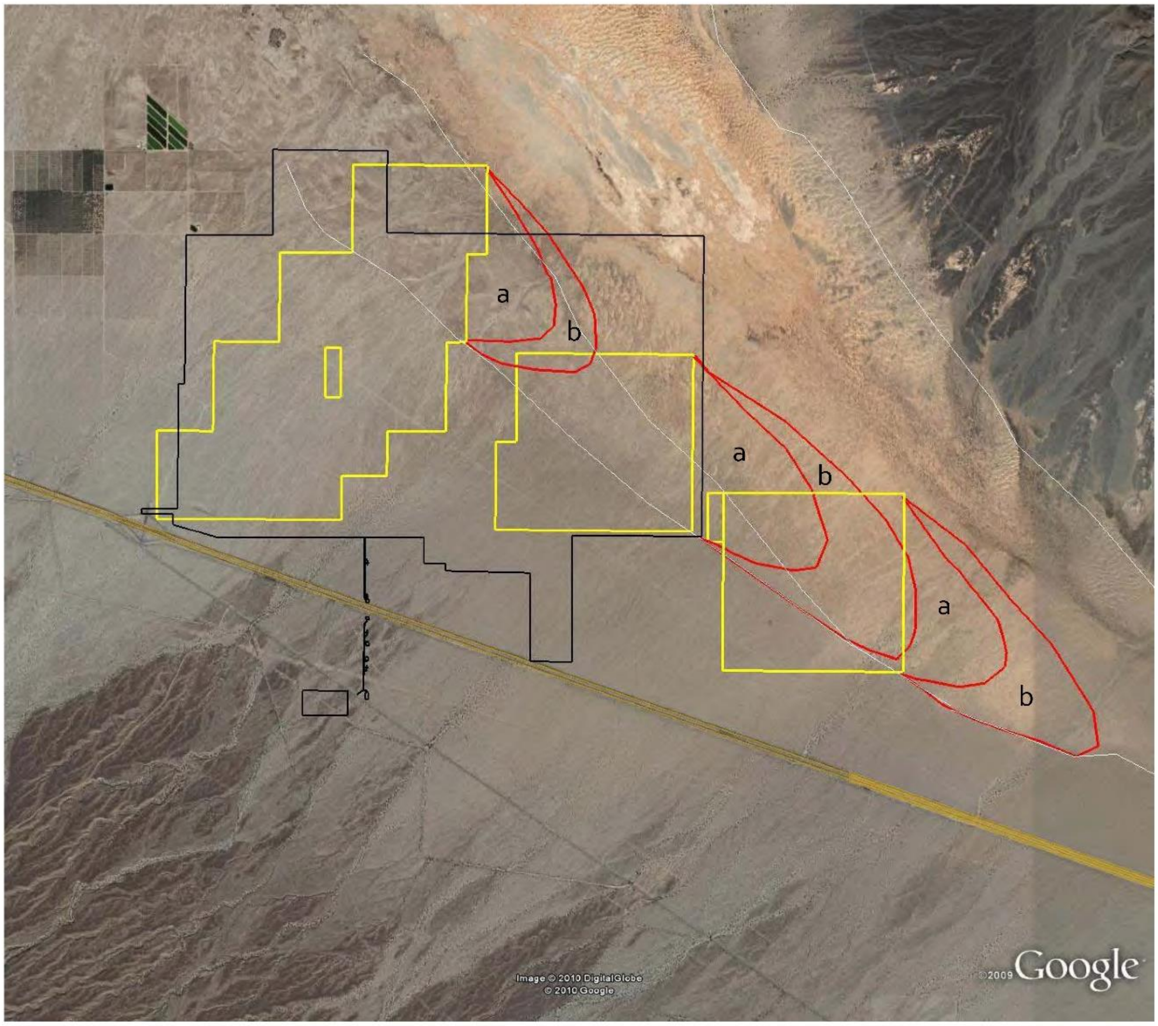

Figure 32. Estimated Potential Zone of Offsite Impacts Due to Wind Transport Disruption.

The Applicant Reconfigured Alternative has similar impacts as the proposed alternative. The Alternative directly impacts 613 acres of shallow sand dune (Zone 3 outer wind transport corridor) and 556 acres of more active deep sand dunes (Zone 2 mid wind transport corridor). Although the footprint in the less sensitive Lower Fan – Shallow Vegetated Dune area is reduced compared with the Proposed Alternative, the impacted area of more sensitive Deeper Vegetated Dunes (Zone 2 of Figure 9) is almost identical (556 acres versus 560 aces for the proposed alternative). Because the area of intrusion into the wind transport corridor is similar, the off-site impacts due to wind transport are similar (in fact slightly increased due to

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the configuration of the eastern block). The area of substantial wind transport impacts (deflation of sand dunes – shown as area a above) is 686 acres compared with 625 acres under the project Preferred Alternative. The area of moderate impacts (area b) is 507 acres, down from 787 acres under the Preferred Alternative (though much of this apparent reduction is due to construction of the arrays in the moderate impact area of upstream arrays which eliminates them from calculation as a moderate impact). The Reduced Acreage Alternative also largely preserves the Central Wash Complex and its associated sandy corridor and habitat. It preserves some of the Northern Wash Complex, though this is still somewhat impacted.

Palen Reduced Acreage Alternative (Revised)

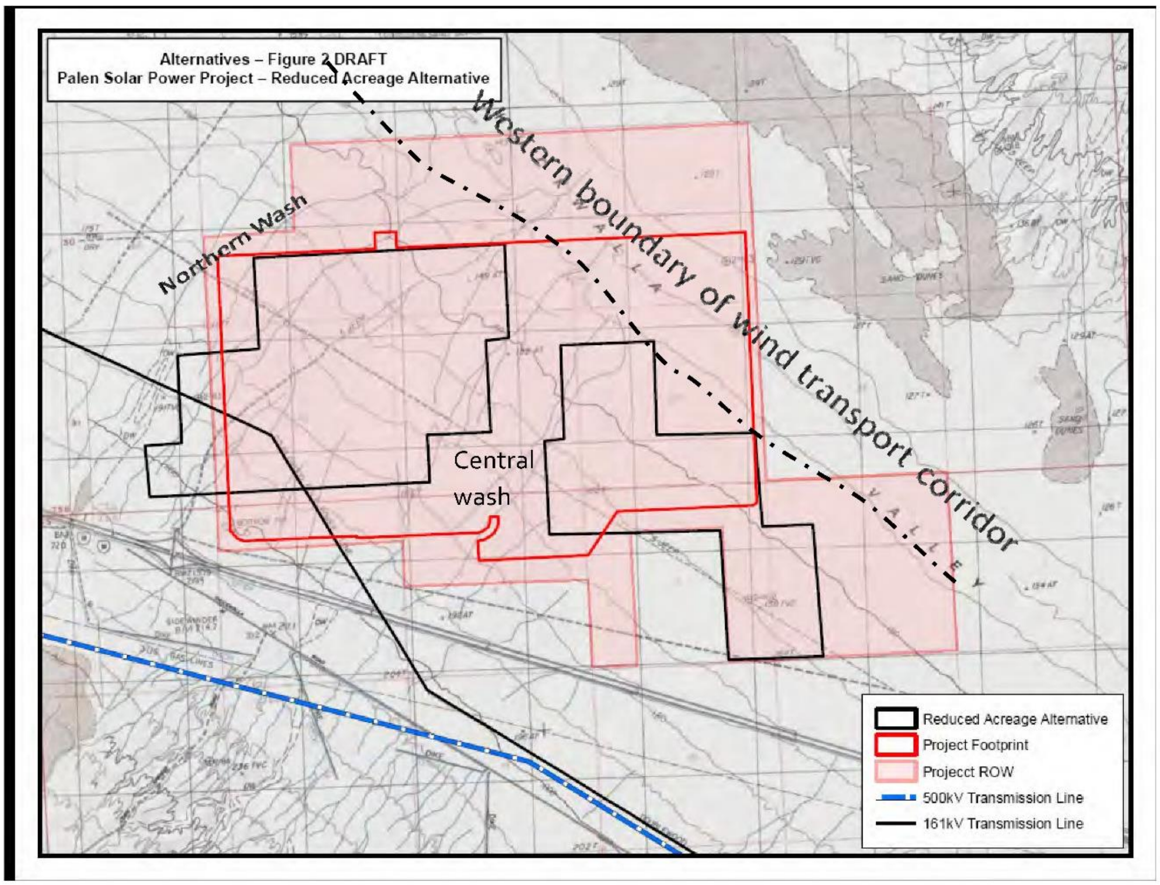

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Figure 33. Palen Reduced Acreage Alternative (note wind corridor boundary is approximate). Source: Helix, 2010.

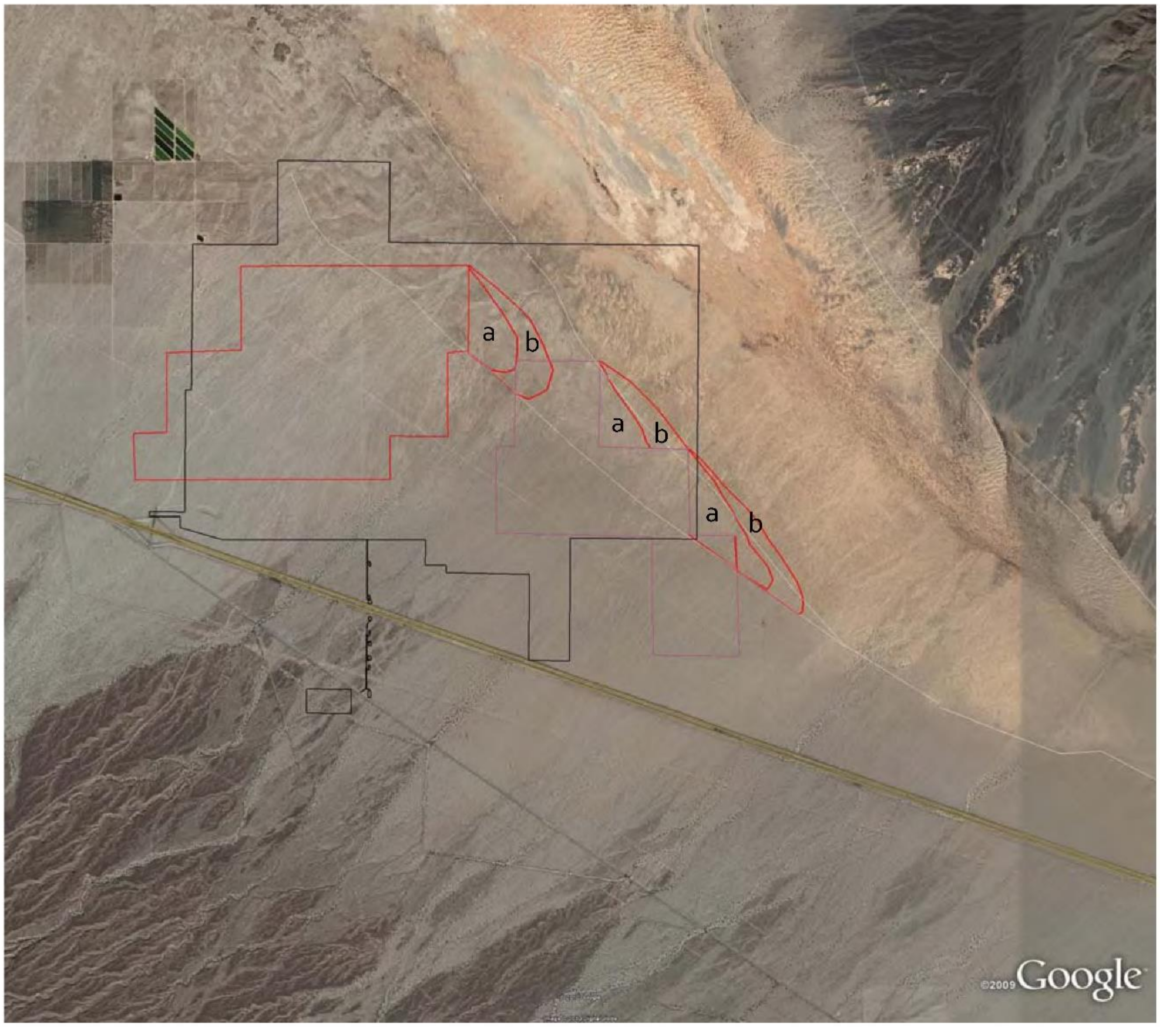

Figure 34. Estimated Zone of Offsite Impacts Due to Wind Transport Disruption.

The Reduced Acreage Alternative (revised) has several advantages over both the Proposed Alternative and the Applicant Reconfigured Alternative. It greatly reduces the area of the project within the Lower Fan, especially in the more sensitive Deeper Vegetated Dune area (Zone 2 of Figure 9) where the area directly impacted is approximately halved. It also reduces intrusion into the wind transport corridor, and so reduces off-site impacts due to wind transport, especially in the more active Zone 2. The Reduced Area Alternative (Revised) has the smallest off-site impacts to wind transport of sand, as well as the smallest on-site impacts in the more sensitive areas of higher sand transport. It directly impacts 293 acres of shallow sand dunes (Zone 3 outer wind transport corridor) and approximately 3 acres of deeper dune (Zone 2 - mid wind transport corridor). The area of substantial wind transport impacts (deflation of sand dunes – area a) is 209 acres compared with 625 acres under the project Preferred Alternative. The area of moderate impacts is 159 acres, down from 787 acres under the Preferred Alternative. Almost all the off-site impacts are in the less biologically valuable and less geomorphically-active Shallow Vegetated Dune area (Zone 3) rather the more valuable and active Deeper Vegetated Dune Area (Zone 2). The Reduced Acreage Alternative (Revised) also largely preserves all three Wash Complexes.

Overall the Reduced Acreage Alternative (Revised) is the superior alternative from a geomorphic perspective.